

IMPACT OF LAPAROSCOPIC TECHNIQUES ON UROLOGICAL SURGERY

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REZUMAT

Tehnicile laparoscopice au influențat semnificativ practica urologică. Urologii au fost de multă vreme dedicați idealurilor chirurgiei minim invazive, progresia spre laparoscopie fiind naturală. Scopul acestui articol este de a accentua beneficiile dovedite ale laparoscopiei pe o gamă largă de aplicații, precum și viitoarele direcții ale laparoscopiei în urologie.

Cuvinte cheie: laparoscopie, urologie, oncologie urologică

ABSTRACT

Laparoscopic techniques have had a profound effect on urological practice. As a group, urologists have long been dedicated to the ideals of minimally invasive surgery and the progression to laparoscopy was natural. The purpose of this review is to outline the proven benefits of laparoscopy over a range of applications and the future directions of laparoscopy in urology.

Key Words: laparoscopy, urology, urological cancer

HISTORY

Although gynaecological surgeons introduced laparoscopy more than a century ago, its first urological application did not take place until 1976 when Cortesi et al performed a diagnostic laparoscopy for impalpable testis.¹ Urologic laparoscopy maintained a primarily diagnostic role for further 15 years. Clayman and Kavoussi at Washington University performed the first laparoscopic nephrectomy on June 25, 1990.² Following renal embolization, the procedure was carried out using 5 ports in 6 hours and 45 minutes, with estimated blood loss of 300 mL. Around the same time, the first laparoscopic varicocelelectomy and pelvic lymphadenectomy were described.^{3,4}

Early series were plagued by long operating times and high conversion and complication rates, but with

perseverance and development of sound and reproducible surgical techniques the laparoscopic approach has been proven as advantageous for a number of operations. Advances in video cameras and imaging technologies, with improved visual field and depth perception, have also contributed to improved results. Further experience has enabled urologists to move beyond ablative laparoscopic surgery to more sophisticated reconstructive procedures.

Laparoscopic nephrectomy, adrenalectomy and pyeloplasty may now be considered as routine procedures. The burgeoning worldwide experience with laparoscopic radical prostatectomy may eventually challenge the place of conventional open surgery for this indication as well, pending the long-term results that prove its oncological safety.

APPLICATIONS

1. BENIGN DISEASE OF THE KIDNEY

Laparoscopic nephrectomy can be performed by a transperitoneal or retroperitoneal route. The transperitoneal approach is the most popular as it affords greater operating space, however the retroperito-

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neal route is more similar to the conventional open approach and enables early vascular ligation. There is no objective advantage for one technique over the other. Hand-assisted laparoscopic nephrectomy, utilising specially designed "hand-ports", are also favoured by some to facilitate tactile sensation, improved blunt dissection, organ retraction, haemostasis and specimen retrieval, however this occurs at the expense of slower convalescence and adds to the procedural cost.⁵

Most patients undergoing laparoscopic nephrectomy will have a poorly functioning kidney on a background of chronic obstruction, chronic pyelonephritis, reflux, dysplasia or renal artery stenosis. The specific indication for nephrectomy often dictates how "radical" the dissection needs to be. The ideal plane of dissection for "simple" nephrectomy is not necessarily deep to Gerota's fascia, particularly in the setting of severe inflammatory change (eg. Xanthogranulomatous pyelonephritis).

Although a prospective randomised controlled trial comparing laparoscopic and open nephrectomy has not been forthcoming, experience with hundreds of patients and in a number of centres has shown a clear benefit for laparoscopic nephrectomy, for benign or malignant conditions.⁶ These advantages are reduced blood loss, lower postoperative analgesic requirement, earlier return to diet, improved cosmesis, shorter length of stay, reduced convalescence and an earlier return to normal activity.

2. ONCOLOGICAL APPLICATIONS

a. Renal cell carcinoma

Laparoscopic radical nephrectomy is standard treatment for tumours up to 8cm in size, when nephron-sparing surgery is not appropriate. Along with the benefits of a less morbid procedure, the technique adheres to well-established principles of oncological surgery with early vascular control and by avoiding tumour spillage with a radical dissection and specimen retrieval in an impermeable bag, morcellation is best avoided, as the few cases of port site metastasis reported have all occurred in association with its use.⁷ The long term outcome following laparoscopic radical nephrectomy compares favourably with conventional open surgery, with 5 year disease-specific survival and overall survival rates of 98% and 81% respectively, for T₁₋₂ lesions.⁸

Renal vein thrombosis, local invasion and tumour size > 10 cm are contraindications to the laparoscopic approach. However, there are a number of reports describing laparoscopic radical nephrectomy for renal cell carcinoma with level I renal vein thrombus,⁹ and size limits vary according to laparoscopic experience. Careful preoperative staging and case selection is important for larger tumours.

Laparoscopic partial nephrectomy is an emerging technique. Published series suggest it is a feasible technique in experienced hands, with acceptable warm ischaemic times and complication rates.¹⁰ Further investigation, including postoperative functional assessment, is necessary to substantiate this approach. Its role will be challenged in the future by percutaneous ablation using radiofrequency or cryotherapy probes.

b. Nephroureterectomy

The aggressive nature of TCC and its uncommon incidence has delayed the widespread acceptance of laparoscopic techniques in the surgical management of upper tract TCC. The conventional open approach caused considerable postoperative pain and delayed recovery, so the advantages of laparoscopic and laparoscopic-assisted (which utilises an incision for distal ureteric mobilisation) nephroureterectomy are obvious. Importantly, long-term outcome using this approach is equivalent to that of open surgery, with 7-year disease-specific survival rates of 72%.¹¹

Various techniques for dealing with the distal ureter have been described. For tumours of the upper ureter and kidney, the authors perform initial transurethral resection of the ureteric orifice, early laparoscopic clipping of the ureter below the level of the tumour, and full extravesical laparoscopic mobilisation after mobilising the kidney. For distal tumours, formal open ureterectomy with bladder cuff via a McBurney incision is performed after laparoscopic nephrectomy. This approach reduces the risk of local recurrence,¹¹ which can occur with spillage of such an aggressive tumour. In all cases, en bloc specimen retrieval is done.

c. Radical prostatectomy

As a measure of the interest in this procedure, a PubMed search using the keyword "laparoscopic radical prostatectomy", to prepare this review, revealed 264 citations. A large number of European and American centres have reported vast experience with this procedure. Operating times, lengthy initially, have improved with surgical experience and operative refinements. There is no doubt that the operative view obtained laparoscopically, owing to magnification, less bleeding and easier access to the retropubic space, exceeds that of open surgery. But does this improved view translate to a functional benefit for the patient?

Unlike the morbidity associated with open surgery of the upper urinary tract, radical prostatectomy is associated with minimal postoperative pain and patients are normally ready for discharge within 3-4 days with catheter in-situ. Nevertheless recent evidence suggests short-term convalescence is more rapid following laparoscopic radical prostatectomy.¹² Advocates of the laparoscopic approach claim that its merits will lie in

improved outcome; however reports to date show continence and potency rates at best equivalent to open surgery, although catheter removal can be achieved earlier in most cases.¹³⁻¹⁵ The incidence of rectal injury also appears to be higher with the laparoscopic approach. Positive surgical margin and progression-free survival rates from the largest series are satisfactory.¹⁶ Until a significant patient benefit is demonstrated, in terms of postoperative course, functional or oncological outcome, this procedure is simply an alternative access technique.

d. Pelvic lymph node dissection

Although a commonly used staging tool previously, the downward stage-migration of prostate cancer in the PSA-era has reduced the number of patients for whom pelvic node dissection is indicated. Nevertheless it has been shown to be an accurate staging tool producing nodal yields equivalent to open surgery, with the benefits of less bleeding, reduced postoperative pain and earlier discharge.¹⁷

e. Retroperitoneal lymph node dissection

The long and steep learning curve remains the biggest obstacle in laparoscopic RPLND, as reported results from major centres performing this work are outstanding. Laparoscopic RPLND for clinical stage I testicular tumours appears to be superior to conventional RPLND in terms of morbidity, costs and has equal diagnostic accuracy.¹⁸⁻¹⁹ A quality of life study has shown that patients prefer surgery to chemotherapy, and laparoscopy over open surgery.²⁰ Laparoscopic RPLND is also feasible for residual mass post-chemotherapy, with minimal morbidity and proven oncological safety.¹⁸

3. DONOR NEPHRECTOMY

The low morbidity associated with the laparoscopic approach is of particular importance to this patient group, and will hopefully see a larger number of kidneys available to meet ever-increasing demand. Laparoscopic donor nephrectomy is technically challenging, having to obtain maximum length of artery and vein, as well as rapid organ retrieval to minimise warm ischaemic time.

4. RECONSTRUCTION

There are currently a number of treatment options for upper urinary tract obstruction. While open pyeloplasty remains the gold-standard, the laparoscopic approach is growing in popularity with very encouraging results. A recent review of 378 procedures (262 dismembered, 37 V-Y and 79 Fenger pyeloplasties) in 6 institutions revealed a mean operating time of 3.1 hours, blood loss 98 mL, hospital stay 3.5 days, and success rate of 95.5% at a mean follow-up of 20.1 months.²¹ Conversion rate was only 1.3% and minor complica-

tions occurred in 8% of patients. Laparoscopic pyeloplasty offers the combined benefits of the success rate of open pyeloplasty with the shorter convalescence of endourological techniques.

Laparoscopy is the most reliable test for the evaluation of a patient with non-palpable testis, with sensitivity and specificity that exceeds any radiological investigation.²² The other advantage of laparoscopy for this indication is that it enables therapeutic intervention at the same time: removal of a hypoplastic testis or, if a healthy testis is discovered, orchidopexy. The latter can be performed laparoscopically by mobilisation of the gonadal vessels, or by using a staged Fowler-Stephens technique, with excellent results.²³

Laparoscopy has other paediatric indications. Extravesical ureteric reimplantation has been reported with success rates comparable to open surgery,²⁴ although experience with the technique is limited.

Laparoscopic techniques for the management of female incontinence, including bladder neck suspension and urethral slings, are yet to demonstrate long-term efficacy adequate to recommend their use over established procedures.²¹

5. ADRENALECTOMY

Laparoscopic surgery has revolutionised the treatment of adrenal disease. While difficult by conventional open surgery, laparoscopic removal is quite straightforward, although identification of the gland can be difficult in patients with excessive retroperitoneal fat. The specific advantages of laparoscopic adrenalectomy, above the usual benefits of earlier recovery, are reduced blood loss and lower complication rate.²⁵ Functioning adrenal tumours, including pheochromocytoma, can safely be removed laparoscopically,²⁶ but it is generally agreed that tumours >5 cm diameter or with evidence of local invasion should be removed by open surgery. Laparoscopic partial adrenalectomy, for selected patients with adrenal disease in a solitary gland, or bilateral disease, is an emerging technique aiming to preserve sufficient adrenal tissue to avoid long-term medical replacement therapy.

6. STONE DISEASE

Laparoscopic ureterolithotomy is a salvage procedure for patients who have failed shock-wave lithotripsy and ureteroscopy. A trans- or retro-peritoneal route may be used to approach the ureter. The fact that it is seldom-used says more for the significant advances in endourological techniques, since reported experience with the procedure has shown it to be safe and reliable.²⁷⁻²⁸

Laparoscopic pyelolithotomy and laparoscopic-

assisted percutaneous nephrolithotomy for large or staghorn stones within ectopic kidneys has been described, but is rarely indicated.²⁹ Laparoscopic management of caliceal diverticular stones is recommended for lithotripsy and endourological failures.³⁰

7. VARICOCELE

Transvenous embolisation remains the mainstay of therapy for this condition, however laparoscopic high ligation should be offered to patients with bilateral varicoceles. It is a relatively straightforward procedure and would be a suitable operation for obtaining laparoscopic experience if not for its limited indication.

FUTURE DIRECTION

Laparoscopic surgical performance is limited by the quality of video imaging equipment. Enhanced video imaging and digital displays (high-definition television or HDTV) should improve the performance of current laparoscopic procedures and facilitate the development of more advanced techniques. To mimic normal three-dimensional (3-D) vision, 3-D video systems have been developed. These systems incorporate a stereoendoscope, which captures an object as two separate off-set right and left images, which are then viewed using special glasses to produce a 3-D image. Skill tests performed using these systems have demonstrated a 25% increase in speed and accuracy of laparoscopic tasks over the standard two-dimensional endoscopic video system.³¹ 3-D imaging particularly facilitates the performance of laparoscopic tasks that require intricate dissection or reconstructive techniques, such as suturing. It may also benefit training and lessen the learning curve for advanced laparoscopic procedures.

The future of laparoscopic urology is likely to see further use of robotics. Currently, this is limited to surgical assistance with directing a laparoscopic camera (i.e. AESOP 1000TS, Computer Motion, Goleta, CA) and the da Vinci system (Intuitive Surgical, Mountain View, CA), a remote surgery system where the surgeon manipulates controls at a workstation that are directly wired to a surgical robot at the operating table. This has the advantage of 3-D vision and conventional surgical manipulation. Although robotic systems appear to reduce the learning curve for advanced procedures,³² cost prevents their widespread use for the time being.

As equipment improves, further laparoscopic frontiers will be established. Already case reports exist describing renal artery aneurysm repair,³³ repair of iatrogenic ureteric³⁴ and bladder³⁵ injuries, ileal ureter replacement,³⁶ continent urinary diversion,³⁷ Boari flap,³⁸ repair of vesico-vaginal fistula³⁹ and bladder augmenta-

tion.⁴⁰ Using a porcine model, researchers at the Cleveland Clinic have developed a technique for laparoscopic radical nephrectomy and level II inferior vena caval thrombectomy, and are currently attempting similar techniques for level III and level IV tumour thrombus.⁴¹ The boundaries are endless, but operating times in these experimental cases is invariably long, and the benefit questionable. The future of laparoscopy lies in the continued pursuit of minimally-invasive techniques not for their own sake, but because there is a measurable benefit to the patient. The current established indications for laparoscopy in urological practice, having demonstrated this benefit, appear likely to remain as such.

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